

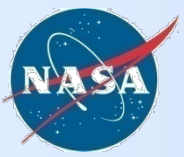


# Feeding the Astronauts During Long Duration Missions

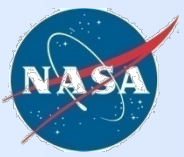


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Shuttle Food System Manager*





# *History*



# *Mercury (1961 – 1963)*

## ■ Objective

- To orbit a manned spacecraft around Earth
- To investigate man's ability to function in space
- To recover both man and spacecraft safely

## ■ Food System

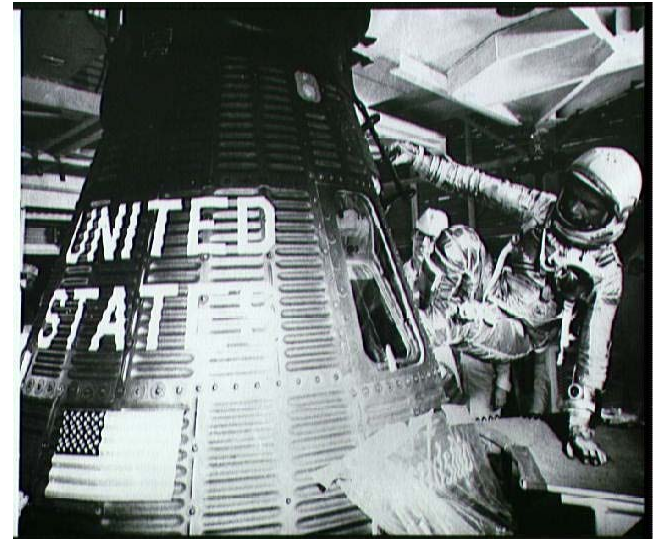
- Highly engineered foods (Meal in a Pill)
- Tube food (not seen or smelled/unacceptable texture)
- Cubes: (no change in flavor, texture: unlike original product)
- No crumbs





# *Gemini (1965 – 1966)*

- Objective
  - To subject men and equipment to space flight up to 2 weeks in duration
- Food System
  - Highly engineered foods (Meal in a Pill)
  - More variety
    - Shrimp cocktail
    - Chicken and vegetables
    - Butterscotch pudding
    - Applesauce





# *Apollo (1968 – 1972)*

## ■ Objective

- To land Americans on the Moon and return them safely to Earth

## ■ Food System

- Improved packaging with improved quality
- Intermediate Moisture Food/ Natural Form Ready-to Eat
- Thermostabilized: flexible packages, aluminum cans
- First to use “spoon bowl” – container that is opened and contents eaten with a spoon



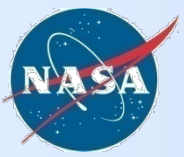




# *Skylab (1973 – 1974)*

- First space station with a laboratory
  - Food stored at time of initial launch; no chance for resupply
  - Ready to eat, rehydratable foods
  - Precooked, thermally stabilized or fresh food
  - Beverages: collapsible plastic accordion-like dispensers
  - Pre-cooked or fresh food kept frozen

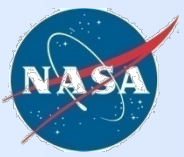




# *Shuttle/Mir (1995-1998)*

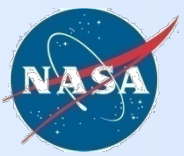
- Typical Russian Space Menu Plan
- 6 Day cycle, 4 meals per day
- Half Russian, half U.S. meals
- Shuttle food warmer used to heat U.S. food
- Shuttle drinking water containers used
- U.S. condiments
- Delivered to Mir by Shuttle and Progress
- **9 month shelf life**





# ***Current Food System***





# *General Food Requirements*

- No refrigerators or freezers on board for food preservation although a small chiller was recently added on the International Space Station for chilling beverages
  - All food must be stable at room temperature for the required shelf life
- All food items are packaged in individual serving sizes
- Minimize crumbs
- Food needs to be wet enough so that surface tension allows for food to “stick” to package and utensils
- Utensils available – fork, 2 spoons, knife, and scissors
- Once food package has been opened or food has been hydrated, there is a potential for harmful bacteria to grow.
  - The food must be consumed within four hours. Otherwise, there is a chance of foodborne illness (nausea, vomiting, diarrhea)
- **12 month shelf life on Shuttle, 18 month shelf life on International Space Station**



# *Thermostabilized and Irradiated Foods*

## ■ Thermostabilized

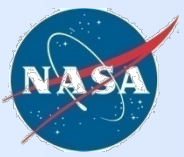
- Retorted in pouches to destroy harmful microorganisms and enzymes
- Ready to eat and only require warming prior to consumption.
- Food is consumed by cutting along the long edge and eating with a fork or spoon.

## ■ Irradiated

- Produced by DoD Combat Feeding Program
- NASA has special dispensation from the Food and Drug Administration (FDA) to irradiate food to commercial sterility
- Harmful microorganisms destroyed through ionizing radiation
- Nine irradiated meat items available
- Packaged in flexible pouches



Thermostabilized Foods



# Beverages

- Either freeze dried beverage mixes (such as coffee or tea) or flavored drinks (such as lemonade or orange drink).
- For coffee or tea, sweetener, powdered cream, or lemon can be added.
- Empty beverage pouches are provided for drinking water.
- Water is added using a needle through the septum.
- A straw is inserted into the septum for drinking.
- A clamp is available to prevent beverage leaving through straw between sips.

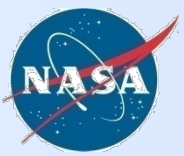




# Rehydratables

- Foods are dried using heat, osmotically, or through freeze-drying
- Water is added using a needle through the septum
  - After water is added, knead the package for a moment to insure that the water makes contact with all of the parts of the food.
- Food is consumed by cutting three sides or an “x” and eating with spoon or fork
- Overwrap
  - For International Space Station missions, these packages are wrapped in a white pouch to increase shelf life.
  - Overwrap will be removed before the food is prepared and heated.





# *Natural Form (Bite Size)*

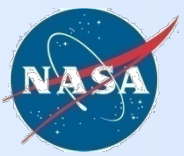
- Commercially available, shelf-stable foods that are packaged in individual serving sizes.
- The moisture of the foods may range from low moisture (such as almonds and crackers) to intermediate moisture (such as brownies and dried fruit). These foods rely on reduced water activity in order to prevent microbial activity.
- Condiments
  - Salt and pepper are in liquid form.
  - Other condiments available, typically in foodservice packs
- Extended shelf-life bread products - Items such as tortillas, scones, waffles, and dinner rolls are available.
- Overwrap
  - For International Space Station missions, these packages are wrapped in a white pouch to increase shelf life.
  - Overwrap will be removed before the food is prepared and heated.





# ***Future***



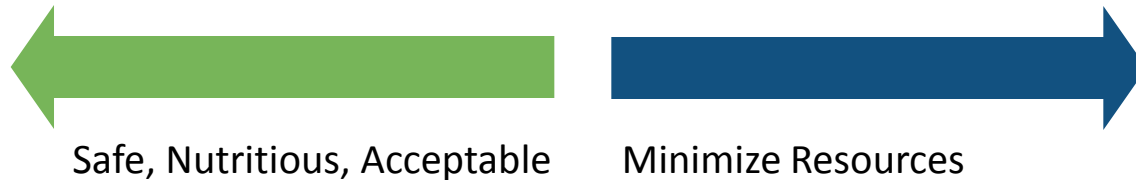


# *NASA Food System Goals and Objectives*

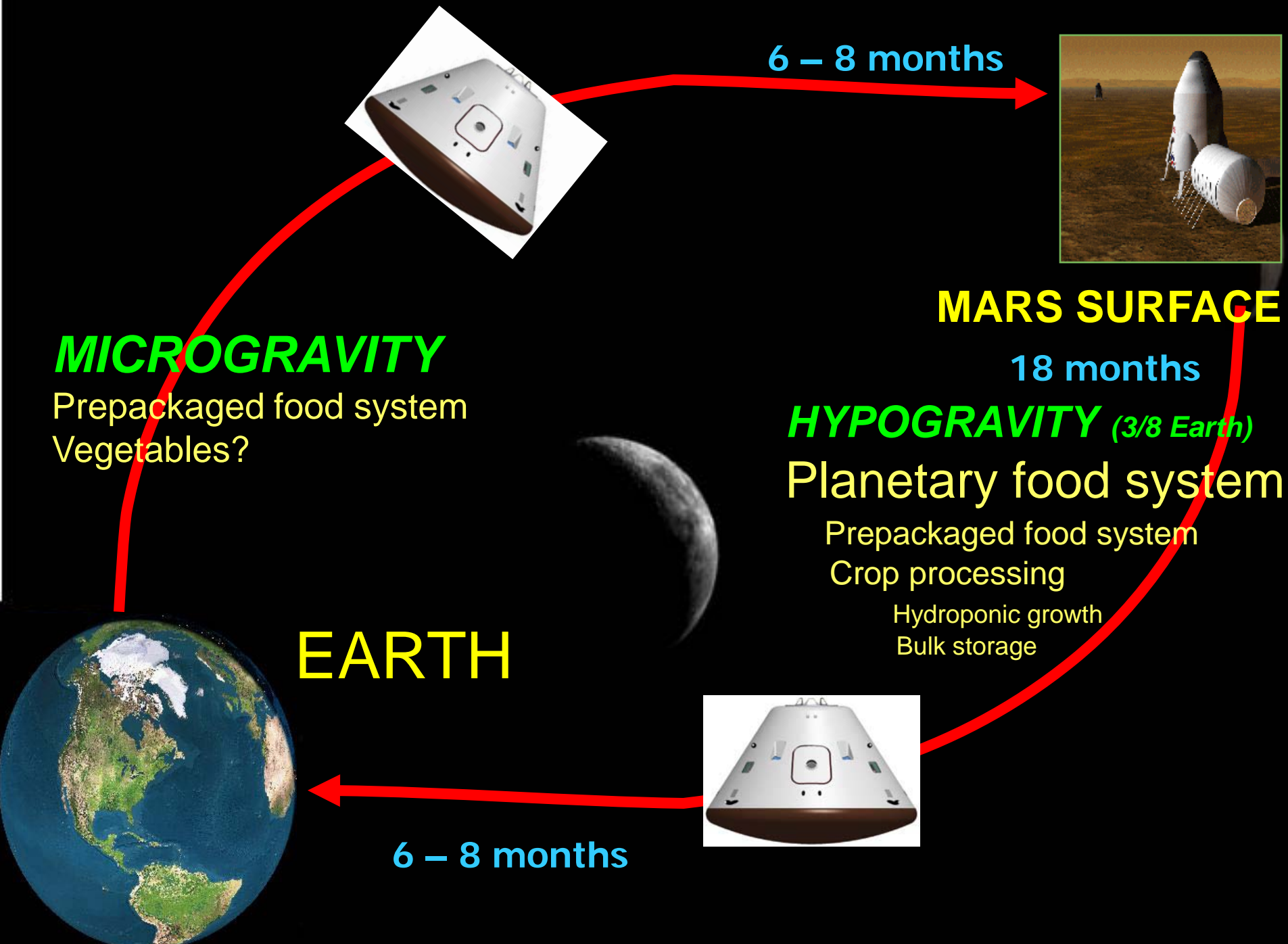
- Develop a food system that is **Safe, Nutritious, Acceptable**  
*and*
- Efficiently balances appropriate vehicle resources:  
**volume, mass, waste, water, power, cooling, air, crew time**

**However,**

At times the food system objectives are at odds with one another.

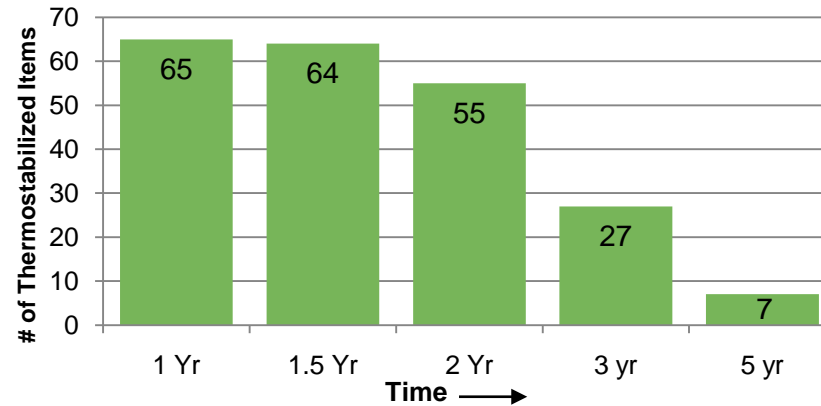


Example: To maintain an adequate food system may require more packaging mass which conflicts with minimize mass.



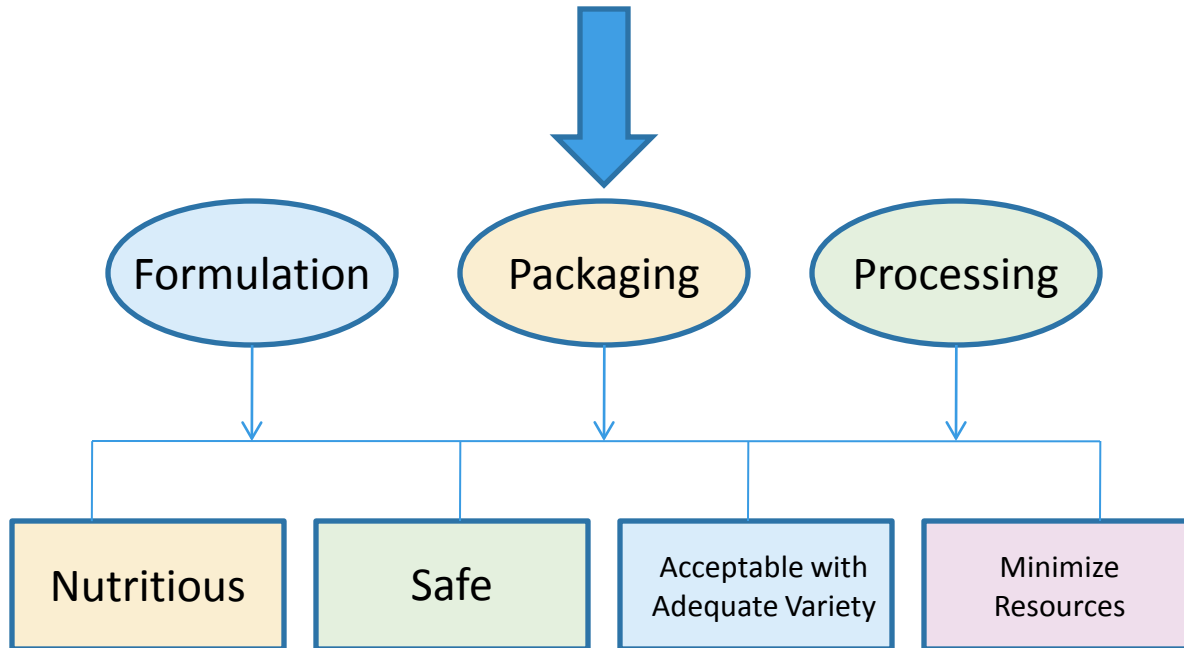


# Research Gap - Packaged Food Shelf Life of 5 Years



2010

2035





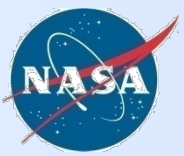
# Research Gap - Optimized Food Packaging for NASA

## ■ Current Packaging

	Oxygen Permeability @ 73.4 °F, 100% RH (cc/100in <sup>2</sup> /day)	Water Vapor Permeability @ 100 °F, 100% RH (g/100in <sup>2</sup> /day)
Overwrap	0.0065	< 0.0003
Thermostabilized & Irradiated Pouch	< 0.0003	0.0004
Rehydratable Lid & Natural Form Pouch	5.405	0.352
Rehydratable Bottom (heat formed)	0.053	0.1784

## ■ New Packaging

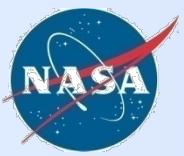
- Same barrier properties as the thermostabilized pouch
- No foil to accommodate microwave sterilization and pressure assisted thermal sterilization
- Flexible to accommodate vacuum packaging
- Transparent to view broken pieces



# Research Gaps – Vitamin Delivery

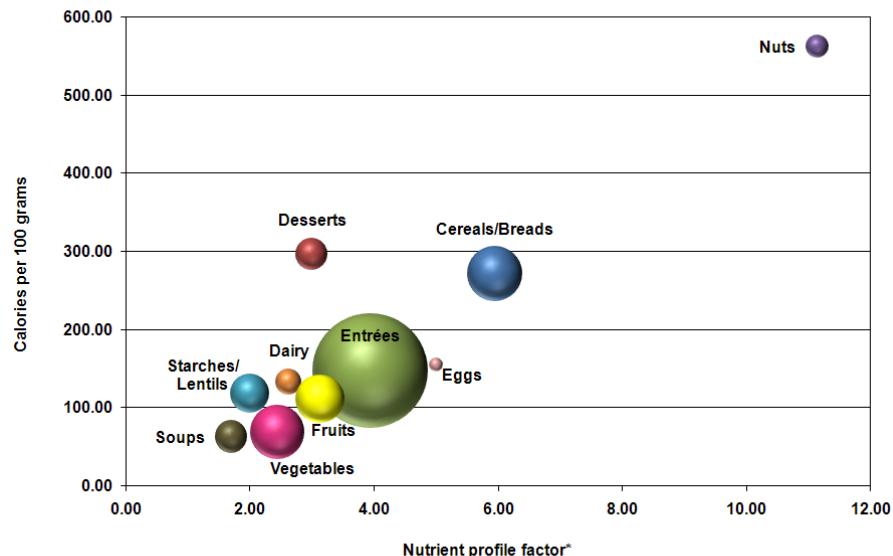
- NASA food items – preliminary results
  - Retort process induces loss of vitamins A and C, thiamin, and folic acid
  - 1 year results
    - Vitamin A, folic acid, and thiamin continues to degrade over time
    - Vitamin C content is zero after one year of ambient storage
- Emerging technology such as PATS starts at a higher level of quality and over time may maintain vitamin content





## Research Gaps – Nutrient Dense Foods

- Mass of transit food system for a Mars Mission has been estimated to be **9660kg**. Packaging waste is **1440kg** of this mass. (Assumes 100% stored food for 1000 days for a crew of 6)
- Reduce the mass of the food by developing nutrient dense foods
  - Reduce water content
  - Increase fat content
  - Add meal replacement bars or nutrient rich beverages







***Thank you!***



Questions?